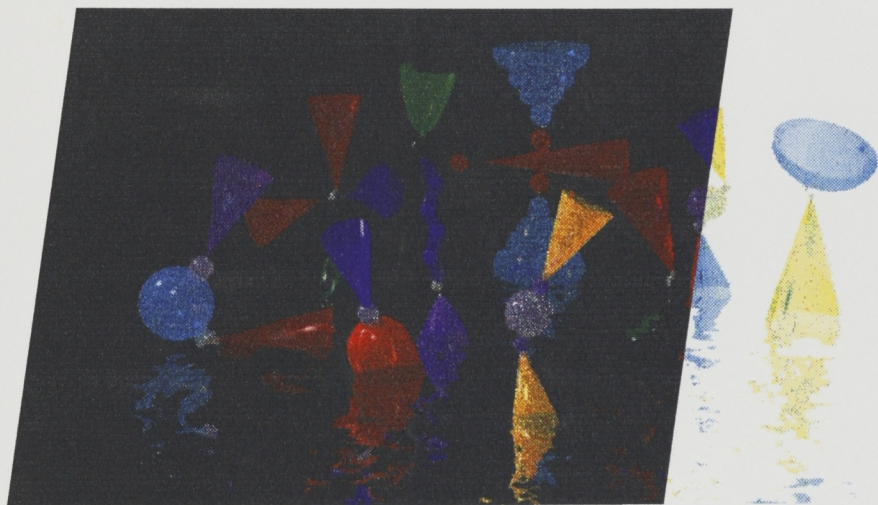


***Computer aided visualisation
& decal manufacture as an aid
to hot glass production.***



Jonathan Baskett



Acknowledgements

This paper would not have been possible without the assistance of many people: Without Annie Trevillean's constant help, advice and interest in my work, making decals, the subsequent paper on how to make decals would have been impossible;

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Last but not least Imogene Landau for your support.

Preface

This paper is presented as fulfilment of the glass workshop requirements and independent workshop proposal (honours) presentation paper.

I hope it will be useful for anyone interested in the deep dark abyss of the computer; whether for computer aided design, decal design, or even marketing.

The section of the paper devoted to the manufacture of decals I hope will be valuable for anyone interested in using enamels or imagery in their work.

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Introduction

In this paper I will talk about the background to my work and why I have used patterning on glass in that work.

I will mention various methods I have used to apply patterns to glass, such as sandblasting, engraving, cane drawing, the graal technique, painting enamel, even hobby paints.

I will talk about how I was introduced to using enamel decals on glass, and why I became interested in making enamel decals. The advantages and disadvantages of using decals on glass will also be discussed.

I will discuss the methods of printing decals as well as the health and safety risks involved in making decals.

I will discuss how computer aided design has benefited me as a glass blower, from designing glass objects 3-Dimensionally to the patterns that wrap around those objects.

I will also talk about how the computer has been invaluable in the process of decal manufacturing.

Marketing strategies and the use of the computer in the creation of my logo, and business stationery will also be discussed.

Finally I will list the commercial decal companies in Australia.

Part I: Patterning on glass and enamel decal manufacture

Why glass?

I have always entertained an interest in design, particularly Scandinavian design. Before I came to art school I travelled extensively throughout Latin America and Europe, mainly Norway and Sweden.

Whilst in Scandinavia I saw the glass they were making there and was instantly amazed. The simplicity of form combined with bold and unusual colour combinations impressed me. It was then that I realised I wanted to be involved in glass.

Hooray for patterns

During the second year in the glass workshop at the Canberra School of Art I realised how much I enjoy pattern.

When in Latin America, I became extremely interested in pre-Columbian and contemporary history and the crafts, mainly textiles from this region.

As opposed to other regions of the world such as Asia, the Middle East and Europe the imagery often used on traditional Latin American textiles both historic and contemporary, (although it's hard to generalise because this region is so diverse) often incorporates elementary and repetitious patterning, with bold and unusual colour combinations.

I also admire African and the North American Indian use of patterning for these same reasons.

Discovering the graal

During second year at art school I discovered the Graal technique.

The graal technique was invented at the Orrefors glass plant in Sweden in 1916. It was a collaboration between Simon Gate the first glass "designer" at the plant, the glass blower Knut Bergkvist and the glass engraver and cutter Gustaf Abels.

The name graal stems from the Swedish writer, Fröding's tale of "den heliga Graal" (the Holy Grail).

I found this technique extremely exciting. It enabled me to successfully use two colours together on a vessel. Quite often these colours would be either complementary or clashing colours usually a cool against a warm colour. The colour combinations are virtually limitless with this technique.

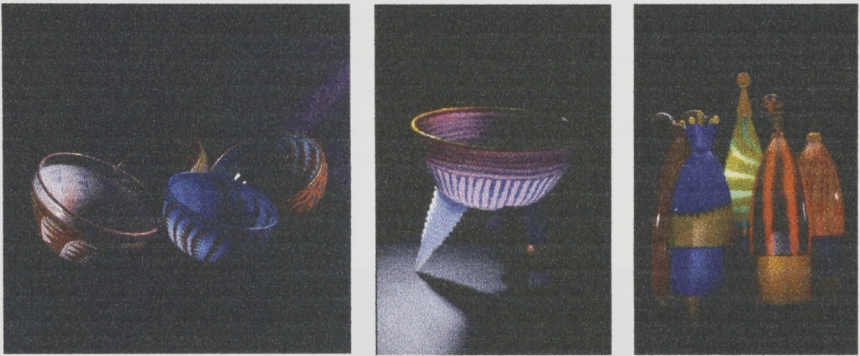
However this technique is difficult, time consuming and requires large amounts of glass colour.

Traditionally this process is done with two teams of glass blowers. Both teams blow out a coloured bubble. One team's bubble is smaller and more rounded than the other. This bubble is heated up half way down the bubble. It is then brought to the bench of the

other team like a punty. The blower at the bench grabs it with his shears and pushes it up over the larger bubble. He then knocks off this overlay bubble. With careful heating and quick timing he then folds this bubble over the first bubble. Once this has been done and marvered in to push the two layers together it is then annealed.

Another method is to shear on an underlay colour onto a bubble, gather the required amount of glass and then roll the parison in coloured powder. Once the required density of colour is achieved the parison is jacked in and cooled in the same manner as the traditional graal blank technique.

When cool this bubble can be taped up and sandblasted or engraved through the outer colour layer to reveal the inside colour. Once the patterning or image has been done the tape is removed and the blank is washed thoroughly inside and out to remove any sand-blasting grit or engraving residue.



Examples of patterns created using the graal technique.

This blank is then heated up slowly in a kiln or anealer. Every glass differs. With the Canberra Art School glass I heat up the blank to between 520° and 560°C (40° to 80°C above the bottom of the annealing range).

When the blank is at top temperature, I make a post on a blow pipe, pick up the blank and quickly flash it in the glory hole. I do this for just long enough so that I can wipe off with a rag any dust on the surface.

Next the blank is heated up and marvered so the raised surface melts in, and is then able to be either gathered over, or papered into what ever shape is required.

This whole process takes an enormous amount of time and is very technical. There is no guarantee that it will work either.

With this process one is able to create beautiful qualities in glass, however the time needed to create each graal piece excluded it from the production market.

I began to search for other ways of applying pattern that would be less time consuming and free me from technique, allowing me to explore my ideas more fully.

Sandblasting

One of the easiest and most common ways to put imagery or patterns onto a blown glass object is by sandblasting. Sandblasting leaves a frosted opaque white quality on the surface of an object.

All that is needed is a sandblasting booth, vinyl tape and a scalpel or scissors. I use 5 cm silver plumbing tape which can found in hardware or plumbing outlets. I cut the tape into strips and wrap it around the object pressing out any air bubbles as I go. If air bubbles are still caught under the tape, it is possible to cut a thin slit into the bubble with a scalpel and gently squeeze the air out of the bubble. This has no affect on the final sandblasting as the slit is too small for sand to penetrate.

Once the object is covered in tape I draw onto the tape, with an indelible pen, the pattern I want sandblasted onto the surface of the object.

Once the pattern has been drawn I use a sharp scalpel to cut away the tape. I then sandblast the pattern onto the vessel using a low pressure.

This process is fairly laborious and one major set back is that the final pattern will have an opaque white finish.



Using sandblasting it is possible to create deep patterns in the glass.

Engraving

I have also used engraving to put patterns onto glass. This is a much more immediate and, for me, a more controlled way of applying pattern. It is possible to create all sorts of effects with this technique and indeed is a discipline in itself. Although I enjoyed the results from engraving I found it took an extremely long time to finish a pattern.

With engraving, as with sandblasting, the end result was fairly predictable; I would still end up with a white pattern on coloured glass. What I really wanted to achieve was coloured pattern on colour like the graal vessels.

I tried rubbing enamel into the engraved and sandblasted sections of these vessels to see what would happen. I would rub this enamel onto a section and fire it onto the vessel. The result was interesting. I would end up with a thin layer of colour on the area. However it was really too thin and resulted in a pasty looking colour pattern.



The rim of this bowl has been engraved deeply.

What's wrong with enamelling?

The problem with enamels is that if you want a dense coating of enamel you have to build up the surface by doing multiple firings. The enamel will blister and burn if you apply it too thickly because the medium with which it is mixed can't burn out properly.

To actually build up a surface layer by layer takes an enormous amount of time and enamel, which isn't cheap. As well as the time factor this process makes it very difficult to register patterns successfully. You need to be very accurate with a paint brush.

By this stage I was getting frustrated with the more traditional techniques of getting patterning onto glass. I happened to have a small tin of hobby paint, the type used for model air planes in my drawer. I thought "Why don't I paint this onto my vessels to see what the pattern looks like?" I was instantly amazed at how easy it was to apply and how quickly it dried (no need for firing cycles). I bought more colours and within a day had decorated more than 10 bowls. I was impressed by the immediacy and variations of this type of painting. It didn't take long however for the paint to flake and peel off.



Examples of patterning using painted enamel.

Working in paradise

Paradise paints (or Hopper enamels) are a high firing enamel developed by David Hopper in Paradise U.S.A. (That explains the name for the enamel). The enamel is a high firing enamel initially used for coating steel. It has been modified for hot glass techniques, especially blowing. It has been developed so that the enamel, rather than burn off at a high temperature, actually melts onto the blown object.

The enamel is painted onto a parison and heated up in the kiln. The kiln must be vented until 500°C. The enamel bakes onto the parison at around 100°C. At this stage you can cool the parison and scratch and rub back into the enamel to get certain effects, or you can continue heating the parison to around 540°C and pick it up on a post and heat it in the glory hole like a graal blank. With the Paradise paints, it is recommended that you gather over the parison as the flame from the glory hole can burn out or reduce the enamel.

During second and third year I used this enamel quite a lot. However I could not get a consistent effect from it. Sometimes the paint would blister, sometimes it would burn out or discolour. The act of blowing out a vessel would stretch and dilute my patterns, merging the enamel with the colour underneath. This often created dark colours or brown, colours I didn't want.

At the start of 1995 David Hopper gave a workshop on Paradise enamel painting and screen printing. He demonstrated how to make decals from Paradise paints. This interested me as a possible solution to my continuing problem of producing patterning on my work in a realistic time scale.

After the workshop Annie Trevillean from Textiles approached me and asked if I needed assistance with producing the decals. Annie works with screen printed fabrics so was a fund of knowledge in the area of screen printing.

Although this technique offered me a way of producing patterns, I was put off making decals with Paradise paints because of their unpredictability.



*The cylinder on the right bears paradise paint patterning.
The left cylinder is a graal.*

What is a decal?

A decal is a water slide transfer of an image created in ceramic inks. The image is printed onto paper and a covercoat is printed over the top. When soaked in water the paper floats away leaving the ceramic ink sticking to the covercoat which is then placed onto the ceramic or glass object. The object is then fired in a kiln and the covercoat burns away leaving the ceramic ink to melt and fuse onto the surface of the object.

Before commencing art school I used to visit Peter Crisp's studio in Bowning on a fairly regular basis. Peter was developing a range of tableware that initially was hand painted with low firing enamels. Due to increasing demand however, Peter was forced to have decal transfers of the images for the plates made up for him.

It is extremely time consuming and difficult to make decals yourself. I was interested in the possibility of someone else making low firing enamel decals for me, so I gave Peter a call. He was extremely helpful and gave me various addresses in Australia and overseas. I called various companies and was surprised at how viable it was to have my patterned artwork made by an external company.

Custom decal manufacture by industry will be discussed in part 2 of this paper "Virtual Glass"

The next section of this paper will be concerned with the production of decals by oneself in the studio/home.

Are you sure?

Firstly you need to be absolutely sure you want to make decals and know exactly what image you have in mind. The process of creating your own artwork as well as preparing and printing a run of Decals is technical, extensive and often frustrating and difficult to perfect. There are many variables involved.

Before proceeding with the technicalities of how to produce a good decal, I can't emphasise enough: Pay attention to every detail. All problems incurred during the water slide decal process can be traced to something that has been overlooked.

Although the making of a water slide ceramic decal appears to be very simple do not deceive yourself. It requires knowledge of the screen printing process, as well as skill and attention to detail.

To make decals successfully you need a room that has a lot of space, good ventilation and lighting. Ideally it needs to have a constant temperature around the low 20's.

There should be plenty of room to lay out all your materials and equipment. I was fortunate in being able to use the main studio in the Glass Workshop to mix the enamels and the screen printing room in the Printmaking Workshop to print the decals.

It is wise to have all materials and equipment used for making the paste at hand before mixing.



Making the paste

For the mixing of the enamels you need a well ventilated room. Commercially mixing is done with a 3 roller mill. This is the most efficient mixer but is expensive to buy. I used a large sheet of glass and a muller for mixing the enamels.

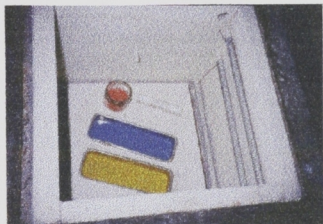
Before mixing it's wise to have all ingredients and equipment handy including rubber gloves, paper towelling or rags, and mineral turpentine for cleaning up.

A ceramic colour (a mixture of finely ground lead glass also known as a flux, and a refectory ceramic or mineral pigment) is used. In the industry enamels and ceramic colours are commonly referred to as inks.

I have only used Blythe enamels from the 2803 range (firing temperature of 520°C to 560°C) for decal manufacture. The reason I have only used Blythe enamels is because I am familiar with them, and I know they fire on well to our glass at school at a low temperature.

Blythe enamels usually contains between 1/4% and 1/2% of water. This moisture must be removed before it is mixed with the decal medium, an oil based medium mixed with the ceramic ink to create a paste. I did this by putting the enamel in a metal baking tray and placed in a kiln on a temperature of 100°C for roughly one and a half hours.

When you place a dry palette knife into the enamel and no enamel sticks to the knife you know the enamel is dry enough to mix.



Enamels can be heated in a kiln or oven to dry out any residual moisture.

Once the enamel is dry it is weighed. It is extremely important to mix the enamel with the decal medium by weight and not volume.

Although each particular colour requires a slightly different ratio, a good starting ratio is 10:4, that is ten parts enamel to 4 parts medium.

Place the enamel away from the edge of the glass (the glass should be free of any grease, dust or foreign material). Mix the medium into the enamel gradually, stirring it with a palette knife as you do. This helps to mix the enamel with the medium evenly, stopping balling of the enamel.

Once all the medium is mixed into the enamel evenly, mixing with the muller may commence, grinding sections of the paste in a figure of eight pattern. If the paste is still too thick it is possible to add slightly more medium. Mix for roughly half an hour. Each particle of enamel must be evenly wetted by the medium.

Once the enamel is mixed into a paste there is now no danger of moisture entering the paste. It may be stored for long periods of time. However, occasional stirring may be necessary to remix the medium with the enamel.

It is generally recommended that you purchase the decal medium and top coat from the same company. If this doesn't happen you may encounter problems during firing such as blistering or pin-holing due to the different burn out temperatures of the medium and covercoat.

Screen printing

Now you are almost ready for printing. First you will need a screen. Screens made with a wood or aluminium frame are best, with a mono filament polyester or metal thread.

Depending on the complexity of the image you will need a screen mesh of 78 to 50 threads per square cm for the enamel paste. Although the 78 thread per square cm mesh will give you finer detail it may clog up after being used for long periods of time. A significantly larger mesh of 32 threads per square cm is needed for the top coat.

I might point out that the continual use of screens with ceramic enamel will wear them down. It is as if you are screen printing fine sand paper.

Screen printing can be really basic such as using cut out paper or masking tape to block out areas of the screen. Alternatively you can print a page of whole colour and then choose to cut out shapes after the top coat has been applied.

If you want to use more than one colour you will need to create artwork that is well registered. Registering by hand requires skill and a lot of patience. I did mine on the computer by separating the two colours and printing them out black.

I used two UV sensitive screens. This process is inexpensive (where available) and professional.

The first colour

A screen printing press or jig used for traditional screen printing is ideal for decal production. A vacuum table is a benefit also, however if you don't have access to this, taping down the paper to the table will suffice.

Either the screen should be raised about a centimetre above the paper or one centimetre sticks should run down the length of the screen. This is called snap printing and aids in the release of the screen from the paper.



A jig is extremely important for registering and ease of printing.



Printing the first colour.

The first colour is printed and left to dry. At this stage I also print the image on acetate to aid in registering the second colour.

Drying racks save a lot of space and keep the prints from being knocked off the table, or anything falling on them such as squeegees, screens, paper etc.

The prints should take two or three hours to dry in a room temperature of 25°C.



A drying rack helps avoid the prints sticking together.

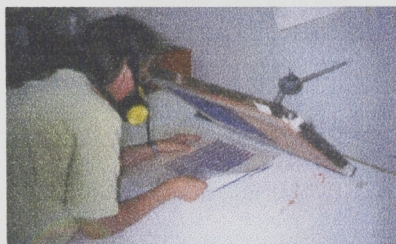
The second colour

It is extremely important that the first colour has dried before you apply the next colour. Failure to do so may result in pinholes or blisters in the final fired result. Even if the colour feels dry upon touching there maybe moisture underneath. If in doubt leave the decals to dry for longer.

The second screen is set up close to where the first screen was on the rack. The acetate is placed precisely under the second screen for registration. The acetate is manoeuvred into place under the screen whilst looking down through the screen until it is perfectly registered. It is then taped into position along the side outside the screen.

Each colour should be slightly less viscous than each proceeding colour so that when it is printed over the last colour it remains smooth and will melt properly when fired. The first layer acts like an absorbent sponge and so if the second colour is too thick the second layer will cake and it will be impossible to obtain a smooth thin layer of enamel.

The paper is then passed under the acetate and in turn registered exactly to the acetate. The paper is then held by suction or taped in position and the acetate moved to one side out of the way of the screen. Having someone to hold the acetate and screen is helpful at this stage. This process of screening is then repeated.



Using acetate to register the second colour.

Once again the enamel must be left to dry thoroughly.

If the top coat is applied before the enamel is thoroughly dry, pin holing will occur.

Both screens should be cleaned with mineral turpentine before they dry so the enamel doesn't get stuck in the mesh.



The finished product.

Applying the covercoat

Once the decals are thoroughly dry the cover coat can be applied.

I used a coarse screen mesh of around 40 threads per cm to apply the cover coat. The sheet of decals is placed under the screen and the cover coat medium screened over the sheet. The covercoat takes roughly 24 hour to fully cure. Even after this period it may remain tacky. For this reason it is a good idea to store the decals vertically or place a sheet of non stick paper between the decals.

Application

This is the fun part. Now most of the hard work is done. However there is still room for error.

Make sure the object on which the decal is to be placed is extremely clean, wiping it with methylated spirits helps. Make sure, though, that there is no lint from the paper towelling or cloth left on the object.

The water in which the decal will be placed in should be clean, free of any impurities and slightly warm. If using many decals remember to change the water frequently to reduce any build up of glue.

Immerse the decal in the water; after roughly thirty seconds the decals should pull away from the backing paper. Place the decal onto the surface of the object face up and gently push any air bubbles out from underneath the decal with a small squeegee or piece of folded paper. If you do not do this, the decal surface over the bubble will simply burn off leaving an unsightly hole in the middle of the image.

After application of the decal leave it for ten to fifteen minutes to dry before firing.



cutting the sheet of decals.



Immersing the decals in warm water.



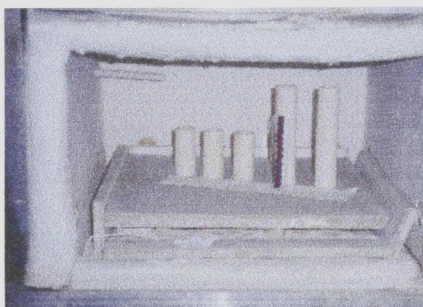
The decal should slide off the backing paper after five to ten minutes in warm water.



*The decal is then placed onto the glass.
Care should be taken to ensure the surface of the glass is absolutely clean.*



Moisture & air bubbles can be removed with a squeegee or by lightly dabbing the decal with a lint free cloth.



The decal is placed in the kiln to dry for at least fifteen minutes, after which firing can commence.

Firing

I use a kiln or lehr to fire the decals onto glass. The cycle below works well for blown glass with thin to medium wall thickness (no thicker than 25mm) The glass at the Canberra School of Art Glass Workshop has a bottom annealing point of 480°C which is why I have included this temperature in the cycle. If the glass is thick or has a different annealing point then this program may need to be modified.

Stage 1.

RAMP: 50⁰ degrees/hr

TEMP: 480⁰ degrees

HOLD: none

VENT: open

Stage 2.

RAMP: Off

TEMP: 540⁰ degrees

HOLD: 30 minutes

VENT: open

Stage 3

RAMP: Off

TEMP: 480⁰ degrees

HOLD: none

VENT: open

Stage 4

RAMP: 50⁰ degrees/hr

TEMP: 150⁰ degrees

HOLD: none

VENT: open

Problems

Below are some problems that may occur.

Underfiring: If the object is fired at a lower temperature than recommended by the colour manufacturer the colours will not fire on properly. The enamel may either rub off when touched or scratched, or it may look raised and have a matt finish.

Overfiring: If the colours are fired above their recommended firing range the colours will burn away, colours will turn to brown or black or even burn off completely.

Too thin a layer: If the decal has been printed too thinly the colour will be insipid and lifeless.

Pin holing/ blistering: These defects are caused during the mixing or printing of the decal caused by, moisture in the enamel or applying the second colour or topcoat before the previous layer has properly dried.

If moisture is present in the enamel before mixing with the decal medium the flow of the paste is restricted. This paste often has a cheesy look to it and actually looks dull once printed onto the decal paper. This is often a good indication as to how the decal will fire. If the colour looks glossy after printing then there is a good chance the decal will fire glossy. However, if after printing the decal looks dull then the decal will almost certainly look dull after firing.

Chipping: If chipping or crazing of the decal occurs after firing then incompatibility of the enamel to the host glass is most probably the problem. Due to large amounts of lead, the enamel will be soft and reasonably compatible with most glasses.

Health and safety

Most of the ingredients used in the manufacture of decals are hazardous in some way or other, therefore:-

It is extremely important that you clean up well after mixing and printing enamels. Where the enamel paste has come in contact with any surface Mineral Turpentine is used for cleaning up. Mineral Turpentine is an extremely poisonous solvent. It affects the nervous system. Therefore when cleaning up there should be adequate ventilation in the room. An extraction hood is beneficial. A mask with an organic vapour filter should be used at all times while making decals. If Mineral Turpentine can be smelled through the mask then either the filter has expired, or you have a leak, or the wrong filter is being used.

Latex or rubber gloves should be worn during the whole decal manufacturing process. These will stop the Mineral Turpentine, decal medium, covercoat and enamel being absorbed through the skin. Goggles should also be worn to protect the eyes.

Rags or paper which have been dowsed in turps for the purpose of cleaning up, should be disposed of thoroughly after making the decals.

It is not recommended that you eat, drink or smoke while making decals. Wash your hands thoroughly after making decals before any food contact.

Smoking around solvents is extremely dangerous. Mineral Turpentine is extremely flammable.

Most enamels contain a high proportion of lead. In addition to this some enamels contain fluorides, antimony and arsenic. Although these ingredients are fused into the theoretically inert glass, it is not recommended you ingest the enamel. This is possible through the skin, respiratory system or by swallowing. Precautions should be taken to minimise these risks.

It is not recommended the decals be placed on the object where they will come in contact with food or drink.

As mentioned before, Mineral Turpentine is an extremely toxic solvent and should be treated as such. Evidence has accumulated over the last decade that chronic solvent exposure can cause irreversible brain damage. Symptoms may include memory loss, mood changes, decrease in intelligence, loss of hand-eye coordination. It is therefore recommended you take maximum precautions in preventing contact with the solvent.

The Johnson Mathey covercoat I used is classified as a flammable material.

Avoid breathing vapour or spray. Inhalation of the vapour or spray in high concentrations and over prolonged periods may cause headaches and in severe cases loss of coordination.

The product is likely to be of low acute oral toxicity. Ingestion of small amounts is unlikely to produce any severe health risk. However, the ingestion of large doses may cause depression of the central nervous system.

The product and its vapour may irritate the eyes. The product may have a defatting action on the skin therefore rendering the skin more susceptible to attack from other substances.

When using this medium wear gloves, goggles and protective clothing.

Inhalation of the Johnson Mathey screen printing medium should be avoided.

This product is of low toxicity and presents little risk to health on ingestion, although the ingestion of large doses may cause depression of the central nervous system. The product is a weak allergen and may cause some irritation to the skin and mucous membranes.

Wear protective gloves, goggles and clothing when using this material.

The making of decals of and computer modelling were developed simultaneously. However it soon became important to use the computer to aid in visualising how the decals would look on the objects I was making.

In the beginning

It wasn't until the first semester of my 3rd year of study at the Canberra School of Art that I was able to commence study in an area of design that I have been interested in for many years- computer aided design.

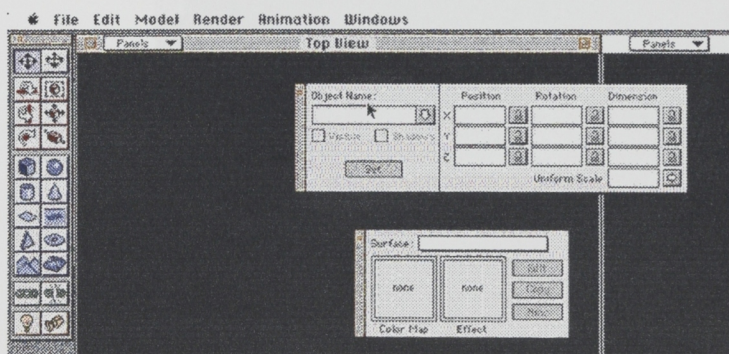
I was included in a pilot program at the school to study 3-dimensional computer modelling. This was done primarily through a 3-d modelling package called Specular Infini-D (2.6n) on the Macintosh system. At the time I had no idea where computer aided design would lead me.

The teacher for the course, Gilbert Riedelbauch is an accomplished toolmaker and a gold and silversmith in his own right. From the start it was emphasised that the computer was simply another tool in the process of design, a means to an end. It was never meant to replace traditional drawing skills. This I believe in strongly.

Before an object can be drawn it must first be visualised. As a product designer one must know how to visualise three dimensionally. A computer cannot replace this ability. During the course we were given various projects in order to develop an understanding of 3-D visualisation, and before we modelled anything on the computer, we first had to have drawings of the object at hand for perusal. The first projects were fun but very basic tests of the computer's power.

Specular Infini-D: the tools

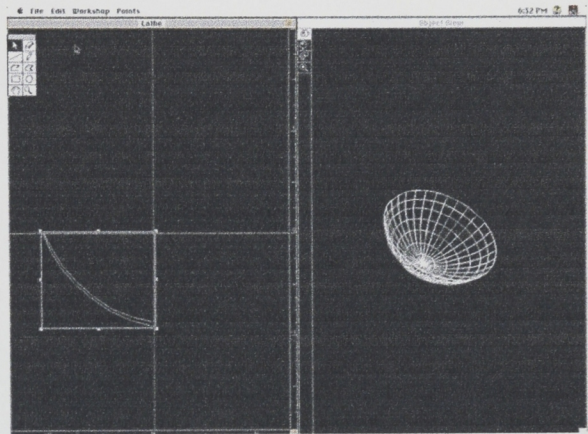
Specular Infini-D, which is the computer software used in this course, is a three dimensional modelling program which uses various tools to construct an object. It's tool box consists of primitive shapes such as spheres, cubes, cylinders, cones, a 2D square tool used for creating walls and defining spaces etc, and a plane tool used to create infinite planes. These forms can be stretched in various ways to distort their shape. A great deal of modelling can be done with these shapes alone.



Infini-D screen. On the left are the various tools used to create and manipulate objects. The two boxes to the right are used to find and name objects and surfaces in the scene.

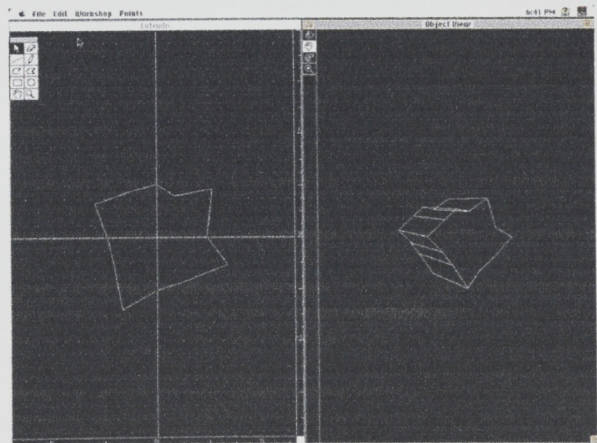
Specular Infini-D also provides the ability to construct three types of custom-made objects; lathe objects, extrusion objects and freeform objects. Each of these constructions has a separate workshop in the package.

The lathe workshop allows the drawing of an outline on a grid and by revolving it around an axis it is transformed into a 3-D object.



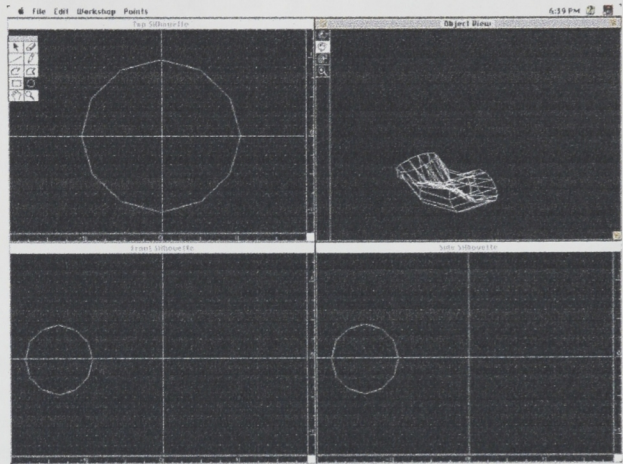
The lathe workshop. The user draws and manipulates an object on the left and the object appears on the right in 3-D

The extrusion workshop allows you to draw an object on a 2-D plane and then extrude it vertically to form a 3-D object (lettering for example).



The extrude workshop. The user manipulates a shape on the left and the form is extruded vertically automatically by the computer to form a 3-D object

The freeform workshop is probably the hardest of the three workshops to understand. An object can either be created in the lathe or extrusion workshop and transported to this workshop, or created in this workshop. A freeform object can be asymmetrical but it doesn't have to be. Where a lathe-formed object rotates around a centre axis, the freeform object can be manipulated from any of the three sides available for modification, those being the top, front and side views.



The freeform workshop. The boxes on the left and lower right are different views of the object on the right hand. By manipulating these three boxes an asymmetrical form can be created.

In Specular Infini-D a complicated form is literally built up piece by piece through all these commands, depending on which is the most relevant, and joined to the main piece or body of the object created.

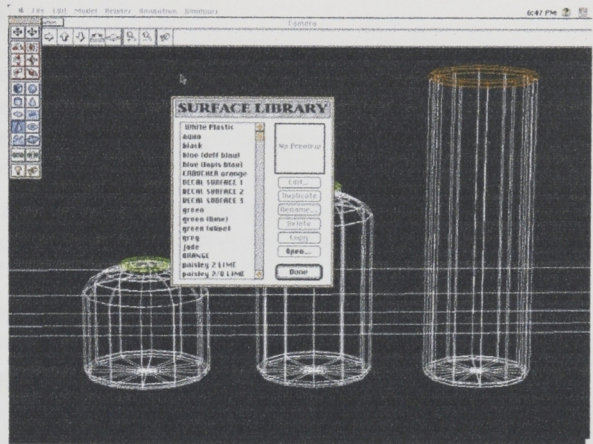
Rendering

The biggest advantage of Specular Infini-D is its realistic rendering of textures and surfaces. With the program there are 27 textures and patterns ready for application to an object ranging from brick to beach glass, from egg shell to gold. All of these surfaces are available for modification.

It is also possible to scan in a surface, anodised aluminium for example, and apply this to an object.

It is possible to create an extremely life-like "virtual object" in a relatively short time. image of rendered goblets 3rd year

With the tools this program offers it is easy to see why it is a valuable tool for many



Surface library. One can use various surfaces already created in Inifini-D to wrap around 3-D surfaces. Alternatively you can make your own e.g. coloured opaque glass.

designer/makers. The versatility of this package enables one to design and visualise on the computer intricate parts and mechanisms. This is ideal for metal and wood designer/makers for example. Often these designers require very complicated techniques and/or expensive materials to make an object.

The Specular Inifini-D package is one way of drawing this object to a realistic finish. Before the designer goes into the studio, both aesthetic and technical problems can be resolved, using the computer.



Goblet series created in 1st semester 3rd year.

How is it relevant?

So how is technology like Specular Infini-D relevant to a glass blower? Running a hot glass studio is extremely time consuming. When would one ever find the time to use a modelling package to develop ideas? Why does a glass blower need technology like for his studio practise?

Man has been blowing glass the same way essentially for 2000 years and managing. How is technology like this going to improve glass blowing? Why don't I just make the product? After all, wouldn't it be quicker?

These are the most common questions asked by people about using a computer to assist in designing a glass product. The next part of this paper will answer these questions.

Firstly, this technology cannot improve glass blowing. This is a skill that requires many hours, even years, of hands-on practice to learn. There are no shortcuts possible. What the computer does is help in the design process, by enabling one to visualise a product before going into the hot glass studio to make it. Computer aided design assists in the research and development of a product.

If one rents one's hot glass studio to other glass blowers for part of the week to share the costs, there is time to develop designs on the computer.

When the furnace is down, for either repair or construction, once again there is the opportunity to use the computer to design or modify designs.

One cannot design glassware by using computer aided design alone. There needs to be a continual dialogue between the computer aided design and the making process. A design might look fantastic on the computer screen and be impossible to make in the hot shop. Modifications to either the glass object or the computer design are necessary. Similar problems may occur with the decals. One might not be able to place a decal around a tight curve for instance, even though this is how the object is designed on the computer.

There needs to be an intercourse between designing on the computer, and blowing in the hot shop to create and resolve the object.

The computer is a design tool.

Why don't I just make the product? After all wouldn't it be quicker?

I don't believe it would be. Before I go into the hot shop to blow glass I need to know exactly what I am making that day, the exact colours and dimensions needed to make the objects. To run a furnace and glory hole at such high temperatures for prolonged periods is expensive. When working in a production studio one cannot afford to use the time in front of the furnace to resolve a design and sit back and look at it and see how it looks and how it can be improved. One needs to use the time as efficiently as possible to make production glassware. Obviously the final piece of glass is going to look different from the computer rendering. It is glass. That's why I am a glass blower. I enjoy working directly with the material and its unique qualities. No computer will ever create exactly the qualities of glass.

Why does a glass blower need technology like this in his studio?

Virtually all the forms I make are symmetrical. The very nature of blowing glass requires the glass blower to use gravity in a controlled fashion to keep the gather of molten glass on centre. If the gather falls off centre the piece will become difficult to control and will almost certainly blow out unevenly.

I use the symmetrical form constantly in my work. For this reason the lathe workshop in Specular Infini-D is a logical way of creating the forms on the computer.

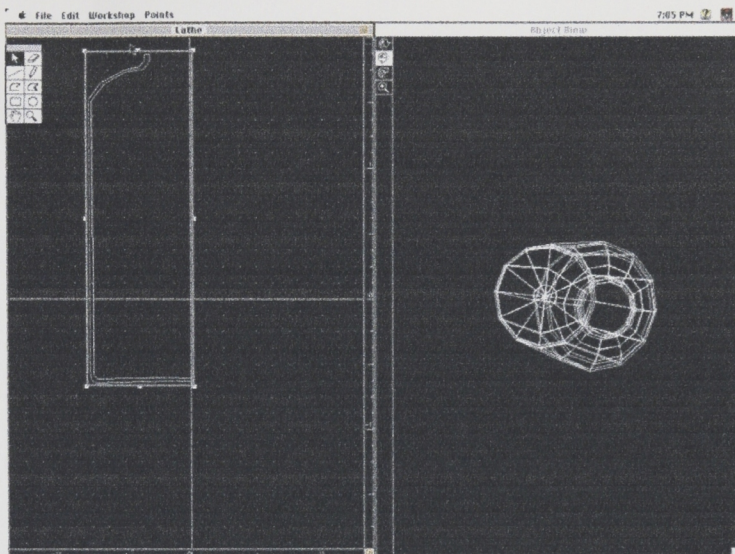
After an initial drawing on paper the vessel is then drawn on the computer. I use the lathe workshop in Specular Infini-D to create images of vessels very quickly. I do this for two reasons.

Firstly, it is much quicker to identify the imperfections in a particular design on the computer than on paper, and change them.

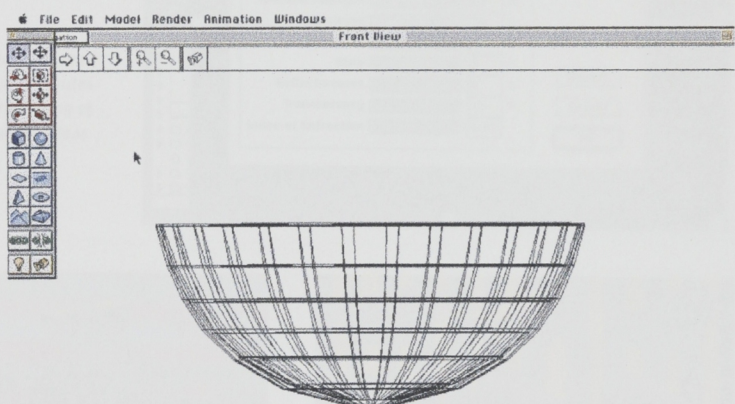
A vessel wall might need to be slightly thinner or taller, maybe the vessel needs to be wider etc. It is quicker for me to do this on the computer than on paper, and more tidy. I don't have sheets of paper lying around (saving trees).

The finished vessel can either be printed out to show its silhouette or can be rendered as close as possible to the final object.

Secondly, once I am satisfied with the result I store the image in a file on the computer specially created for vessels (there are other files for patterns, textures and renderings). This way I am continually building up a bank of images that are completed forms or forms that can be manipulated and altered for different projects.



lathe workshop showing wall thickness of a vase. To make the renderings more realistic the wall thickness was created to assimilate the actual thickness of the final vase.



Black and white print of a bowl in wire frame. By viewing the bowl this way it provides an effective way to visualise a form before making it.

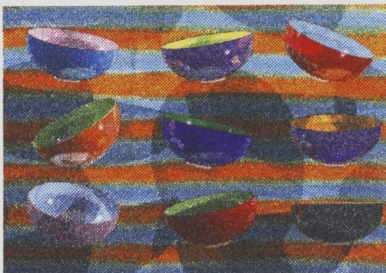
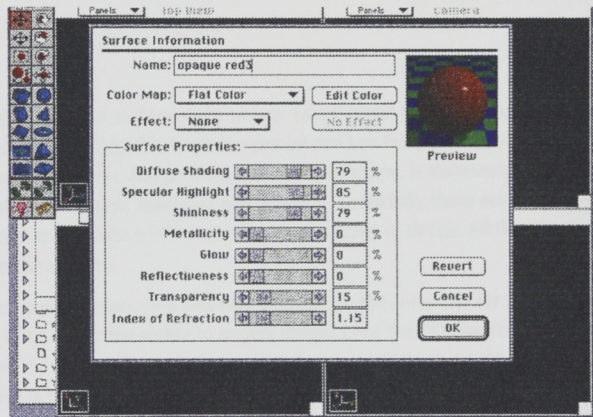
Colour variations

Colour has always been important in my work. Once I have a form on the computer, for example, a bowl that has one colour for the body and another colour for the lip, I can examine an infinite number of colour combinations of this bowl by the click of a button.

I have programmed into the computer various qualities of the glass such as diffuse shading, specular highlight, shininess, metallicity, glow, refraction, reflectiveness, transparency and index of refraction. By adjusting these qualities up or down in percentage values I can create a realistic virtual glass.

It may take about 15 minutes to program the surface attributes of the glass into the computer. Once I have created a base glass, it is easy to create many different coloured glasses by changing the colour in the 'Edit Colour' button in the surface information dialogue box. This takes seconds. Each colour is created to match a specific coloured glass that is available on the market. The variety of colours possible is only limited by the number of commercial glass colours available.

Surface Information dialogue box, showing surface attributes for realistic rendering of opaque red glass.



Final renderings of two groups of bowls created in 2nd semester 3rd year. Once the bowl has been created in Infini-D it is very easy to repeat the design and apply different colours for visualisation.

Printing

There are various options available regarding print outs of the final rendering. Probably the most accessible is a bubble jet print out. The quality of various bubble jet printers differs so it is hard to generalise about quality but generally the end result is satisfactory. Looking at the print out it is quite obvious however that the image is computer generated.

Here at the Canberra School Of Art we have a Canon Clio printer which requires a type of paper that is covered with a thin layer of clay. The advantage of this is the ink bleeds very slightly into the clay, merging colours better than a bubble jet print which tends to look pixilated. The quality of this type of print is slightly better than that of a bubble jet.

Ultimately there is the option of a Dye-sublimation print-out. This type of print out gives the image a very professional and realistic look. It is very close to a photograph. Unfortunately this comes at a price, approximately \$10 for an A4 page. However I believe it is worth it. The finished rendering is amazingly similar to a photo of a real glass object. Sometimes people have not been able to tell the difference.

Decal design

As mentioned in part one of this paper; in 1995 I discovered the technique of making decals from enamels- both high fire (Paradise paints) and low fire enamels such as Blythe enamels. As discussed earlier, this process, although rewarding, is extremely difficult to master, requiring a lot of time, materials and patience. Thankfully there are many commercial companies in Australia which can make small batches of decals. All that the company requires is the artwork.

I chose to create my artwork on a software package on the computer for various reasons. Specular Infini-D has the ability to import images onto the 3-D objects I have created. This allows me to visualise exactly how the patterns will work on the final design before the object is made.

It is extremely important when making a decal, because of the cost and time involved in decal manufacture, that the patterned design is going to work on the glass vessel. It is not practical to make a sample decal to test if a pattern is going to work on a vessel.

Visualisation on the computer is an excellent way of working out which patterns will work on which form.

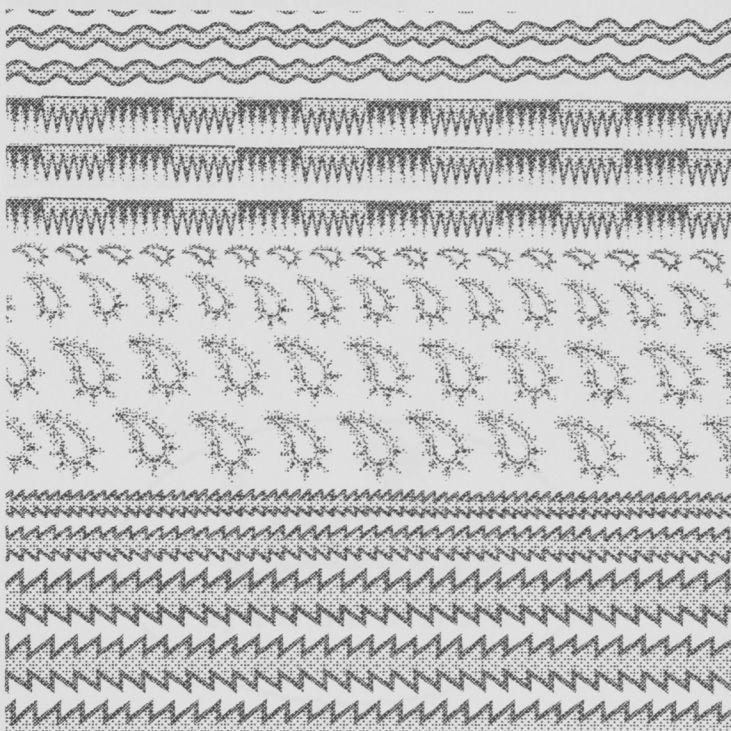
Adobe Photoshop is a common 2-D Macintosh software package used primarily for making and manipulating pictures and images. It is possible to create representations of patterning to be mapped onto the surfaces of 3-d models using this software.

Aldus Freehand enables one to create patterns very quickly. The patterns are tight and limited to two colours. It is possible to quote the exact Pantone colour number needed for the pattern which I can then quote to the decal company (some colours are impossible to make in enamels. I had a lot of trouble finding a purple that I could use for example).

When these patterns are transferred over to Adobe Photoshop the same Pantone numbers are kept on the patterns. This enables me to visualise the glass objects as close to their realistic colours as possible. At this stage it is very easy to change the colours of the vessels and also the colours in the patterns with a click of a button. This facility makes computer aided design an attractive option for exploring a design. Literally over night I can render twenty or thirty colour variations of a design.

Aldus Freehand and Adobe Illustrator are used by most of the decal manufacturing companies in Australia. This facilitates the set up of the artwork, reducing the set up charge by the company. By creating the artwork in either of these packages I can format the size of the page of decals to the specifications of each individual decal company.

The document is then copied on to a floppy disk and sent to the decal company. There is no room for error by the decal company as the file on the floppy disk is exactly the same as the original document. It is a very quick and easy way of transporting my images to the company-no smudges, stains or creases on the artwork.



Computers for marketing

Once I have created computer images of the vessels with the patterns on them I can use the print outs for marketing purposes. I can mail the images out to shops or customers to get orders before I even go into the hot shop and make the pieces. This way I know exactly how many of each form, colour and pattern I need to make at the start of the day, utilising blowing time more efficiently.

LOCITO is the name of my glassware business.

It is my intention to create my own homepage on the INTERNET advertising my business LOCITO and the production glassware I will be making through this business.

The INTERNET has various locations on it reserved for the Arts and Crafts. By having the computer available on the business premises it would be theoretically possible to be contacted from anywhere in the world.

The INTERNET is accessed worldwide by a broad cross section of the community. This makes it potentially an ideal form of advertising.

This form of advertising could eventually make it possible to sell directly to the public and by-pass the traditional means of marketing one's work through retail outlets. This would increase the profit margin of each article marketed significantly.

The software packages with which I've learnt to create these vessels and patterns on the computer are also used to create my business logo, letterhead and Homepage.



CONCLUSION

I have explained various patterning techniques and in particular, decal manufacture. Decal manufacture from the information I have gathered is quite a widespread and common patterning technique in industry. However the small studio designer/maker or artist has been reluctant to venture into this area.

Why is that? Perhaps it is because information in this area is difficult to come by or maybe this process is considered too commercial?

Designing my decal patterns on the computer and then manufacturing the decals myself or having a company make the decals has freed me up enormously both in creativity and the time taken in making each individual glass.

I am much more free to experiment and develop new ideas.

Designing glass on the computer has allowed me to explore ideas and colour variations much faster than ever before.

Initially it can take some time to construct a design/s on the computer. Once this has been done, with a click of the mouse button an infinite number of high quality images varying in colour and pattern can be created for visualisation.

There are other advantages that can be gained.

In the near future I will be working in a studio assisting another glass blower. I will not get as much time to experiment with ideas in the hot shop. This is where the computer would be helpful. I can visualise on the computer exactly what I will make when I get the opportunity to blow glass.

Computer images of the work I intend to make can be developed into a professional marketing tool.

When negotiating commissions, computer images would be extremely beneficial to clients for visualisation.

If someone else was to make my glass for me, a company for example; computer aided drawings would be an excellent way of expressing my ideas to the potential glass maker.

When I go travelling I could take computer drawings with me for reference.

Once there becomes a sufficient awareness of my designs on the INTERNET and through Galleries, shops etc I will be able to concentrate solely on the designing and making of my work, this is the what is most important to me.

The computer is an integral part of the design process in my work now. I hope I will be able to continue utilising it in the future.

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APPENDIX I LIST OF SUPPLIERS

Below is a list of the various decal companies in Australia I have contacted. Their prices and quantities vary so it is worth shopping around.

Petch Printing

Post: 12 Currunga Place, Lavington, NSW 2641

Factory: Units 1&2 Hudson Crescent,

Lavington, NSW 2641

Mobile 015 26 1022

Fax/Phone A/H: 060 25 8943

Decal Tech Aus.

Post: 68 Bakers Road North Coburg, Vic 3058

Phone: (03) 9354 9344

Benz Tech

Post: P.O box 62 Riverstone NSW 2765

Street Address: Unit 5/24 Wellington St. Riverstone NSW 2765

Phone: (02) 627 1166

Fax: (02) 627 3069

Mobile: 0414 8121133

These are three companies I have found, no doubt there are more in Australia.

APPENDIX ii GLOSSARY

Adobe Illustrator	Adobe Illustrator is a 2-D software package used by Graphic Artists and Designers for the creation of images,labelling, lettering etc.
Adobe Photoshop	Another 2-D software program used by Graphic Artists and designers.
Aldus Freehand	Aldus Freehand is a 2-D software package used by Graphic Artists and Designers for the creation of images, labelling, lettering etc.
Antimony	Antimony (element symbol Sb) is a toxic element. Contact should be avoided at all times.
Arsenic	Arsenic is a poisonous chemical element. Ingestion, Inhalation and contact should be avoided at all times.
Complementary colours	These are the opposite colours to each other on the colour wheel ie. green and red, blue and orange and purple and yellow.
Fluoride	A binary compound of fluorine with another element.
Fluorine	A non metallic element (symbol F) group.
Gather	To gather glass is the action of dipping a blow iron or solid steel rod into a furnace to pick up an amount of molten glass on the end of the pipe.
Glory hole	The glory hole is the name given to an enclosed chamber a glass blower uses to re-heat glass.
Marver	The marver is a steel table used in the glass blowing hot shop. It is used by rolling the hot glass gather over it to shape and cool the gather
Muller	A muller is a stone or glass object with a flat base for mixing an enamel with a medium into a paste.
Parison	A parison is the name given to the initial glass bubble on the end of a glass blowers pipe. It is quite small roughly the size of a fist.
Post	A post is a ring of glass around a glass blowers pipe. One usually makes a post to pick up graal blanks and parisons from a kiln or lehr to blow out further.
Solvent	A substance,usually a liquid, able to dissolve other substances
Specular Infini-D (2.6n)	Specular Infini-D (2.6n) is a 3-D modelling software program. It is not as precise as CAD or drafting packages. It is primarily used for visualisation of products, objects etc. It is commonly used by graphic, industrial and product designers.